FREQUENCY MODULATION SPECTROSCOPY OF IODINE AT 532 NM USING A VIBRATING MIRROR

Tong-Long Huang[*,**], Yan-Rung Lin[*], Wang-Yau Cheng[*], Jow-Tsong Shy[*], and Hai-Pei Liu[**]
[*]Department of Physics, National Tsing Hua University, Hsinchu, Taiwan 300, ROC
[**]Institute of Optical Sciences, National Central University, Chung-Li, Taiwan 320, ROC

Abstract

We demonstrate a simple and low cost method to observe the frequency modulation (FM) saturated absorption spectrum of $^{127}I_2$ at 532 nm. We use a vibrating mirror with modulation frequency of 570 kHz to modulate the laser frequency. Preliminary result is shown for the iodine P(54) 32-0 line.

Introduction

Since the iodine-stabilized Nd:YAG lasers have many advantages over the iodine-stabilized He-Ne lasers [1], several frequency doubled Nd:YAG laser systems have been used to study the hyperfine spectrum of iodine near 532 nm. Among the available methods of saturated absorption spectroscopy, frequency modula-tion (FM) spectroscopy has great advantages in high modulation frequency and without modulating the laser frequency directly. In the experimental schemes of frequency modulation, electro-optic and acousto-optic modulators are usually employed to modulate the laser frequency. Recently, T. Mitsui *et al.* [2] observed the FM spectrum of ^{85}Rb at wavelength of 780 nm with a vibrating mirror instead of an EOM and locked the laser frequency at the crossover resonance line. They showed that the PZT used in the humidifier can vibrate a mirror at large enough amplitude at a frequency around 600 kHz such that the reflected beam has enough phase modulation index for FM spectroscopy. They also showed that the residual amplitude modulation (RAM) is very small.

In this paper, we use a periodically poled lithium niobate (PPLN) to produce the second harmonic of the 1064 nm Nd:YAG laser. The 532 nm output of the PPLN is used to observe the FM saturated spectrum of iodine using the vibrating mirror method. Preliminary result is presented here.

Experimental Setup

The experimental setup is shown in Fig. 1. We use a Lightwave Electronics Model 126 Nd:YAG mono-lithic diode-pumped nonplanar ring laser, emitting 500 mW at 1064 nm, as the light source. An optical isolator (OFR IOT-5-YAG-HP) is used to prevent the optical feedback effect. The laser frequency is externally doubled with a quasi-phase-matching PPLN monolithic crystal ($0.5 \times 5 \times 45$ mm^3) which is heated to phase-matching temperature about 190 ℃. We obtained a second harmonic power of about 1 mW at 500 mW fundamental pumping power. The output of the PPLN crystal passes through a short wavelength pass filter to eliminate the fundamental wave. After reflected by a polarizing beam splitter, the pump beam passes through a quarter wave plate and the I_2 cell for obtaining saturated absorption spectrum. The I_2 cell has a length of 6 cm and its cold finger is kept at 0 ℃ using a thermoelectric cooler. Finally, the probe beam reflected from a mirror on the piezoelectric transducer (PZT) and is received by a fast detector (New Focus Model 1801). The PZT has a modulation frequency of 570 kHz and an applied voltage of 50 V_{P-P} (peak to peak). The FM spectrum is obtained by a RF lock-in amplifier and recorded by a chart recorder.

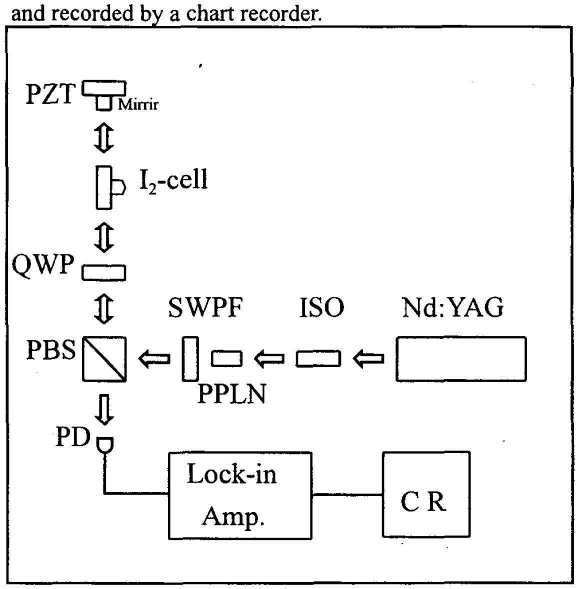

Fig. 1. The experimental arrangement for FM spectroscopy using a vibrating mirror. PZT: piezoelectric transducer, QWP: quarter wave plate, PBS: polarizing beam splitter, SWPF: short wavelength pass filter, ISO: optical isolator, PD: photodiode, CR: chart recorder.

Results and Discussions

We have obtained the saturated absorption spectrum of iodine molecule using the FM spectroscopy with a vibrating mirror. The hyperfine spectrum of the P(54)32-0 transition [3] is shown in Fig. 2. However, the signal-to-noise ratio is not good and there exists a background. The background could due to the RAM and Doppler background. It can not be applied to stabilize the laser frequency. At present, we are improving our system by adjusting the reflected mirror to reduce the RAM, temperature controlling the PZT to stabilize its resonant frequency and using the modulation transfer technique to reduce the Doppler background. We will also optimize our system and lock the laser to the iodine hyperfine transition. The results will be presented at the conference. After the laser is locked to the hyperfine peak, it will be frequency compared with the iodine-stabilized 532 nm Nd:YAG laser at the Center of Measurement Standards in Taiwan, ROC.

Acknowledgements

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References

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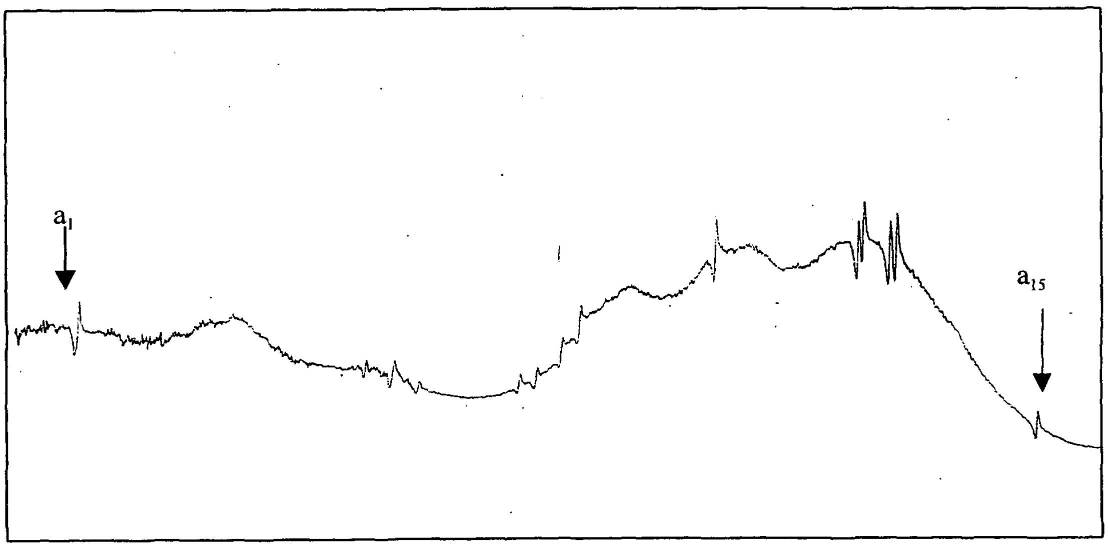

Fig. 2. The FM spectrum of iodine P(54) 32-0 line near 532 nm using a vibrating mirror.